

Claims

5 1. A horizontal spool tree assembly for controlling fluid flow through a production tubing string within a well, the production tubing string defining a tubing annulus surrounding the tubing string, and the tree assembly adapted for use with a workover string for fluid communication with the tree assembly, the tree assembly comprising:

10 a spool body defining a spool body central bore for receiving a tubing hanger therein, and a spool body production passageway extending laterally from the spool body central bore for fluid communication with a production line;

15 the tubing hanger within the spool body central bore and sealed to the spool body, the tubing hanger adapted to support the production tubing string therefrom, the tubing hanger having a tubing hanger production bore for fluid communication with the production tubing string and a tubing hanger production passageway extending laterally from the tubing hanger production bore for fluid communication with the production passageway in the spool body;

20 an annulus passageway extending laterally through the spool body below the tubing hanger for fluid communication with the tubing annulus;

25 a first annulus valve for controlling fluid flow between the tubing annulus and an annulus line;

30 a second annulus valve positioned downstream from the first annulus valve with respect to the tubing annulus for controlling fluid flow between the tubing annulus and the annulus line;

25 a workover flow path in fluid communication with the annulus passageway and passing through the spool body, laterally into the tubing hanger, and upward through the tubing hanger to the spool body central bore above the tubing hanger, thereby providing fluid communication between the workover string and the tubing annulus;

30 a crossover flow line in fluid communication with the annulus line between the first and second annulus valves and the production line; and

 a crossover valve positioned along the crossover flow line.

2. A horizontal spool tree assembly as defined in Claim 1, further comprising:

5 a production valve positioned on the spool body for controlling fluid flow along the spool body production passageway.

10 3. A horizontal spool tree assembly as defined in Claim 2, further comprising:

15 the crossover flow line is in communication with the production line downstream from the production valve.

20 4. A horizontal spool tree assembly as defined in Claim 1, wherein the workover flow path extends through a lateral port in the tubing hanger spaced below the tubing hanger production passageway.

25 5. A horizontal spool tree assembly as defined in Claim 1, further comprising:

25 a first closure member positioned within the tubing hanger production bore in the tubing hanger.

30 6. A horizontal spool tree assembly as defined in Claim 5, further comprising:

30 a second closure member positioned above the tubing hanger and the first closure member for isolating the spool body central bore between the first and second closure members.

35 7. A horizontal spool tree assembly as defined in Claim 1, further comprising:

35 another production valve on a block connected to the spool body for controlling fluid flow along the production line.

8. A horizontal spool tree assembly as defined in Claim 1, further comprising:
5 a lower first seal between the tubing hanger and the spool body;
an intermediate second seal between the tubing hanger and the spool body;
a third upper seal between the tubing hanger and the spool body;
the workover flow path into the tubing hanger being spaced between the first seal and the second seal, and the tubing hanger production passageway being spaced between the second seal and third seal.

10 9. A horizontal spool tree assembly as defined in Claim 1, wherein the second annulus valve is positioned within a block connected to the spool body.

15 10. A horizontal spool tree assembly as defined in Claim 1, wherein the first annulus valve is positioned on the spool body for controlling fluid flow along the first annulus passageway through the spool body.

20 11. A horizontal spool tree assembly as defined in Claim 1, wherein the workover flow path is in fluid communication with the annulus passageway between the first and second annulus valves, such that the first annulus valve controls fluid flow during a workflow operation.

12. A horizontal spool tree assembly as defined in Claim 1, further comprising:
25 a first closure member positioned within the tubing hanger production bore in a tubing hanger;
a second closure member positioned within the tubing hanger production bore in the tubing hanger above the first closure member; and
the workover valve is positioned along the workover flow path for controlling fluid flow to the first annulus valve during a workover operation.

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13. A horizontal spool tree assembly as defined in Claim 12, wherein the workover valve is positioned on the spool body for controlling fluid flow along the workover flow path.

5 14. A horizontal spool tree assembly for controlling fluid flow through a production tubing string within a well, the production tubing string defining a tubing annulus surrounding the tubing string, and the tree assembly adapted for use with a workover string for fluid communication with the tree assembly, the tree assembly comprising:

10 a spool body defining a spool body central bore for receiving a tubing hanger therein, and a spool body production passageway extending laterally from the spool body central bore for fluid communication with a production line;

15 the tubing hanger within the spool body central bore and sealed to the spool body, the tubing hanger adapted to support the production tubing string therefrom, the tubing hanger having a tubing hanger production bore for fluid communication with the production tubing string and a tubing hanger production passageway extending laterally from the tubing hanger production bore for fluid communication with the production passageway in the spool body;

20 an annulus passageway extending from the tubing annulus upward through a portion of the tubing hanger and laterally through the tubing hanger into the spool body and to an annulus line; and

an annulus valve for controlling the fluid flow along the annulus passageway.

25 15. A horizontal spool tree assembly as defined in Claim 14, further comprising:

a workover flow path exterior of the spool body and in fluid communication with the annulus passageway and extending through a lateral port in the spool body to the spool body central bore above the tubing hanger.

16. A horizontal spool tree assembly as defined in Claim 14, further comprising:

a production valve positioned on a block exterior of the spool body for controlling fluid flow along the production line.

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17. A horizontal spool tree assembly as defined in Claim 14, further comprising:

a crossover flow line in fluid communication with the annulus line and the production line.

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18. A horizontal spool tree assembly as defined in Claim 14, further comprising:

a first closure member positioned within the tubing hanger production bore in the tubing hanger.

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19. A horizontal spool tree assembly as defined in Claim 18, further comprising:

a second closure member positioned above the tubing hanger and the first closure member for isolating the spool body central bore between the first and second closure members.

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20. A horizontal spool tree assembly as defined in Claim 14, wherein the annulus valve is positioned on the spool body.

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21. A horizontal spool tree assembly for controlling fluid flow through a production tubing string within a well, the production tubing string defining a tubing annulus surrounding the tubing string, and the tree assembly adapted for use with a workover string for fluid communication with the tree assembly, the tree assembly comprising:

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5 a spool body defining a spool body central bore for receiving a tubing hanger therein, a spool body production passageway above the tubing hanger extending laterally through the spool body to a production line, and an annulus passageway below the tubing hanger extending laterally through the spool body for fluid communication between the tubing annulus and an annulus line; and

10 the tubing hanger sealed to the spool body and adapted to support the production tubing therefrom, the tubing hanger having a tubing hanger production bore extending axially therethrough for fluid communication between the production tubing string and the spool body production passageway.

15 22. A horizontal spool tree assembly as defined in Claim 21, further comprising:

15 a workover flow path extending entirely within the spool body from the production passageway in a spool body to the annulus passageway in a spool body.

20 23. A horizontal spool tree assembly as defined in Claim 21, further comprising:

20 an annulus valve positioned on the spool body for controlling fluid flow along the annulus passageway.

25 24. A horizontal spool tree assembly as defined in Claim 21, further comprising:

25 a first closure member and a second closure member each positioned in a tree cap above the tubing hanger.

30 25. A horizontal spool tree assembly as defined in Claim 21, further comprising:

30 a production valve on a block exterior of the spool body for controlling the fluid flow along from the spool body production passageway to the production line.

26. A horizontal spool tree assembly as defined in Claim 21, further comprising:

a workover valve positioned on the spool body for controlling the fluid flow along the workover flow path.

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27. A horizontal spool tree assembly as defined in Claim 21, further comprising:

a workover flow path exterior of the spool body for fluid communication between the production line and the annulus line.

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28. A horizontal spool tree assembly as defined in Claim 27, further comprising:

a workover valve exterior of the spool body for controlling the fluid flow along the workover flow path.

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29. A horizontal spool tree assembly as defined in Claim 27, further comprising:

a first production valve for controlling fluid flow along the production line;
a second production valve for controlling fluid flow along the production line;
a first annulus valve for controlling fluid flow between the tubing annulus and the annulus line;
a second annulus valve for controlling fluid flow between the tubing annulus and the annulus line; and
a workover flow path is in fluid communication with the production line between the first production valve and the second production valve, and is in fluid communication with the annulus line between the first annulus valve and the second annulus valve.

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30. A horizontal spool tree assembly for controlling fluid flow through a production tubing string within a well, the production tubing string defining a tubing annulus surrounding the tubing string, and the tree assembly adapted for use with a

workover string for fluid communication with the tree assembly, the tree assembly comprising:

5 a spool body defining a spool body central bore for receiving a tubing hanger therein, a spool body production passageway above the tubing hanger extending laterally through the spool body to a production line, and an annulus passageway below the tubing hanger extending laterally through the spool body for fluid communication between the tubing annulus and an annulus line;

10 the tubing hanger sealed to the spool body and adapted to support the production tubing string therefrom, the tubing hanger having a tubing hanger production bore extending axially therethrough for fluid communication between the production tubing string and the spool body production passageway;

15 a first annulus valve for controlling fluid flow between the tubing annulus and the annulus line;

20 a second annulus valve positioned downstream from the first annulus valve with respect to the tubing annulus for controlling the fluid flow between the tubing annulus and the annulus line; and

25 a fluid flow path in fluid communication with the spool body central bore above the tubing hanger and the annulus passageway between the first annulus valve and the second annulus valve, the fluid flow path providing a workover flow path for fluid communication between the workover string and the tubing annulus when the first annulus valve is open and the second annulus valve is closed, and the fluid flow path further providing a crossover flow path for fluid communication between the production line and the annulus line when the first annulus valve is closed and the second annulus valve is open.

31. A horizontal spool tree assembly as defined in Claim 30, further comprising:

30 the fluid flow path extending entirely within the spool body from the production passageway in the spool body to the annulus passageway in the spool body.

32. A horizontal spool tree assembly as defined in Claim 30, wherein the fluid flow path is in communication with the spool body production passageway between the spool body central bore above the tubing hanger and a production valve for controlling fluid flow to the production line.

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33. A horizontal spool tree assembly as defined in Claim 30, further comprising:

a control valve along the fluid flow path to control fluid flow.

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34. A horizontal spool tree assembly as defined in Claim 30, wherein the fluid flow path is exterior of the spool body for fluid communication between the production line and the annulus line.

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35. A horizontal spool tree assembly as defined in Claim 34, further comprising:

a first production valve for controlling fluid flow along the production line;
a second production valve for controlling fluid flow along the production line;
the fluid flow path is in communication with the production line between the first production valve and the second production valve.

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36. A horizontal spool tree assembly as defined as Claim 30, wherein the fluid flow path extends from the spool body central bore above the tubing hanger downward through a portion of the tubing hanger, then laterally outward through the tubing hanger and into the spool body, and in communication with the annulus line between the first annulus valve and the second annulus valve.

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37. A horizontal spool tree assembly for controlling fluid flow through a production tubing string within a well, the production tubing string defining a tubing annulus surrounding the tubing string, and the tree assembly adapted for use with a workover string for fluid communication with the tree assembly, the tree assembly comprising:

a spool body defining a spool body central bore for receiving a tubing hanger therein, and a spool body production passageway above the tubing hanger extending laterally through the spool body to a production line;

5 the tubing hanger sealed to the spool body and adapted to support a production tubing therefrom, the tubing hanger having a tubing hanger production bore extending axially therethrough for fluid communication between the production tubing string and the spool body production passageway; and

10 an annulus passageway extending upward into the tubing hanger and laterally outward through the tubing hanger and through the spool body to an annulus line.

38. A horizontal spool tree assembly as defined in Claim 37, further comprising:

15 a workover flow path exterior of the spool body and extending from the production line external of the spool body to the annulus passageway.

39. A horizontal spool tree assembly as defined in Claim 38, further comprising:

20 a workover valve positioned along the workover line for controlling fluid flow during a workover operation.

40. A horizontal spool tree assembly as defined in Claim 38, further comprising:

25 a first production valve and a second production valve each positioned along the production line for controlling fluid flow; and

the workover flow path extends from the production line between the first and second production valves to the annulus passageway.

41. A horizontal spool tree assembly as defined in Claim 38, wherein the workover flow path is in fluid communication with the annulus line between a first annulus valve and a second annulus valve each annulus valve controlling fluid communication along the annulus line.

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42. A horizontal spool tree assembly as defined in Claim 37, further comprising:

a first closure member and a second closure member in a tree cap above the tubing hanger.

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43. A horizontal spool tree assembly for controlling fluid flow through a production tubing string within a well, the production tubing string defining a tubing annulus surrounding the tubing string, and the tree assembly adapted for use with a workover string for fluid communication with the tree assembly, the tree assembly comprising:

5 a spool body defining a spool body central bore for receiving a tubing hanger therein, and a spool body production passageway above the tubing hanger extending laterally to a production line, and an annulus passageway below the tubing hanger extending laterally through the spool body for fluid communication between the tubing annulus and an annulus line;

10 the tubing hanger sealed to the spool body and adapted to support a production tubing string therefrom, the tubing hanger having a tubing hanger production bore extending axially therethrough for fluid communication between the production tubing string and the spool body production passageway; and

15 a workover flow path extending from the spool body central bore above the tubing hanger downward through a portion of the tubing hanger, laterally outward through the tubing hanger and into the spool body, and laterally inward through the spool body to the tubing annulus.

20 44. A horizontal spool tree assembly as defined in Claim 43, further comprising:

25 an annulus valve positioned on the spool body for controlling fluid flow along the annulus passageway.

45. A horizontal spool tree assembly as defined in Claim 43, further comprising:

30 a workover valve positioned on the spool body for controlling the fluid flow along the workover fluid passageway.

46. A horizontal spool tree assembly as defined in Claim 43, further comprising:

a first closure member and a second closure member in a tree cap above the tubing hanger.

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47. A horizontal spool tree assembly as defined in Claim 43, further comprising:

a production valve positioned on a block exterior of the spool body for controlling the fluid flow along from the spool body production passageway to the production line.

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48. A horizontal spool tree assembly as defined in Claim 43, wherein the workover flow path extending laterally inward through the spool body to the tubing annulus includes a portion of the annulus passageway in the spool body.

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